Space Weather Technical Forecast

Issued on Friday, 14 July 2023 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares likely (R1-R2 Blackouts). Chance of G1/Minor Storms today (14 Jul).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Has been Moderate with a peak flare M2.1 from AR3372 in the northeast disc at 13/1920 UTC. This is a large region with a small delta spot in its complex trailer. AR3363 and AR3367 also have delta spots, potentially two for AR3363, with AR3367 recently developing the delta spot due to a slight growth of penumbra on some intermediate spots. However despite AR3363 being another large region it has remained stable with no significant flare activity. The remaining regions are generally smaller, simpler and stable or decaying, giving at total of eight regions on the disc. Of these regions one is new and yet to be numbered. This region is emerging on the east limb and appears to be the leading spot of a group that trails behind the east limb, and so may eventually rotate onto the visible disc as a large region. A CME was seen leaving the Sun from AR3361 around 13/1830 UTC, and is yet to be analysed but is unlikely to be Earth directed.

Solar Wind / Geomagnetic Activity: A CME arrival occurred at 13/1550 UTC, this most likely the CME from the 10th. However this CME was weak, and so the solar wind as observed at L1 by ACE/DSCOVR, remained at background levels, with only slight increases from 300 km/s to around 350 km/s, peaking at 363 at 13/2223 UTC. The density was initially below average, but increased to above average average levels through the morning and afternoon, peaking at 22 ppcc at 13/1601 UTC, thereafter declining to average levels to end the day. Total magnetic field strength (IMF, Bt) was initially weak then increased to moderate levels, peaking at 14 nT at 13/1624 UTC. The north-south component was weakly negative (southward) or positive until the CME arrived, then fluctuated with a maximum deflection of -7nT. Phi angle has been positive (away from the Sun), apart for an initial negative (towards the Sun) orientation until13/0200. Geomagnetic activity has been Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, has been at background. High energy electron flux (greater than 2MeV) was Background to Moderate, peaking 443 pfu at 13/1830 UTC. The 24-hour integrated fluence was below the Active (1e8 integrated pfu) threshold on a decreasing trend. A fluence of 8.81e6 pfu was recorded at 14/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to Low activity expected, with an ongoing likelihood of M-class fares and a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: A glancing CME arrival is possible around 14/1600 UTC from the filament eruption off the south disc on the 11 Jul, although the bulk of this CME is expected to miss.

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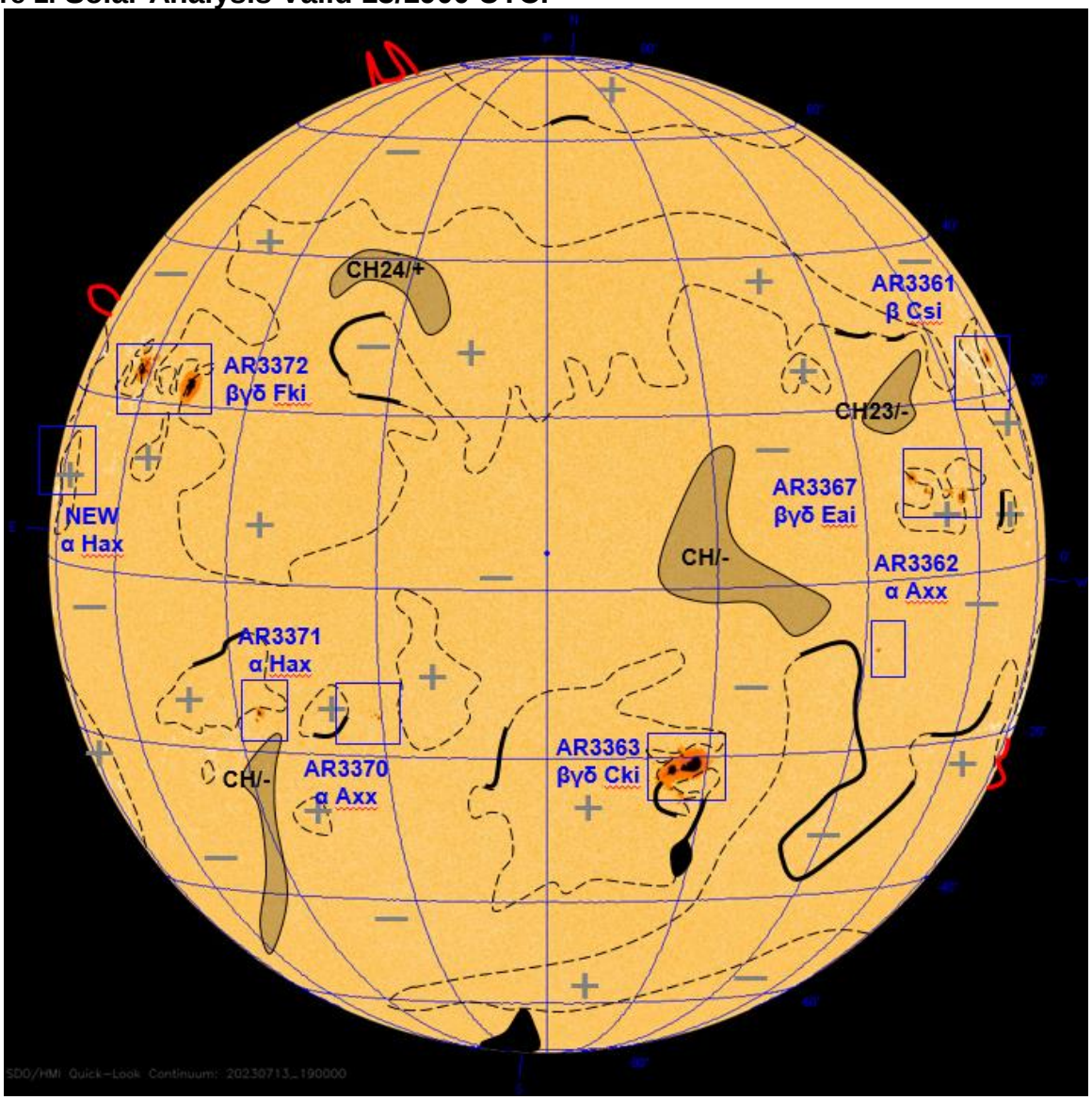
Earth is also likely to connect to the elevated wind of CH23 this morning (14 Jul), although probably only increasing to slightly elevated levels. Initial Quiet (Kp 0-2) conditions are likely to become Unsettled to Active (Kp 3-4), with a chance of G1/Minor Storm (Kp 5) intervals today, especially if the CME arrives. Activity then eases tomorrow onwards to becoming mainly Quiet, with isolated Unsettled intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight chance of reaching the S1/Minor Storm threshold through the period, should any larger flares occur. High energy electron flux (greater than 2MeV) is likely to remain at Background to Moderate levels at first then from day 3 (16th) the high energy flux may increase to become Moderate to High as the potential CME and CH HSS arrivals are likely to enhance flux values. Electron fluence is expected to remain below the Active threshold (1e8 integrated pfu) but with a rising trend from day 3 (16 Jul).

Figure 1. Solar Analysis Valid 13/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There remains one low confidence CMEs in the forecast: a glancing CME arrival is possible around 14/1600 UTC from the filament eruption off the south disc on the 11 Jul, although the bulk of this CME is expected to miss.

There is also a low confidence coronal hole fast wind anticipated to arrive either this morning. On the previous rotation a strong connection occurred with solar winds peaking over 600km/s, however the CH appears much more reduced and fragmented on this occasion, coroborated by a recent slight increase in the solar wind at STEREO A with the solar speed only increasing from around 300 km/s to near 400 km/s. Enlil indicates a stronger connection today (14 Jul) to around 500 km/s, albeit contaminated with the CME arrivals. Any solar wind enhancement is most likely to ease tomorrow onwards. However, there is a chance the solar wind could return to slightly elevated levels later in the forecast period as there appears to be a weak coronal hole feature centre disc in the western hemisphere.

Overall, this gives low confidence to the geomagnetic forecast with current Quiet conditions expected to prevail until any enhancement occurs later day 1 or early day 2 (13 or 14 Jul), increasing to Unsettled to Active, but with a chance of rising to G1/Minor Storms, mainly with any CME arrival. There is a very low chance of G2 Moderate storms on day 2 (14 Jul), most likely if the arrivals combine into a larger single arrival. Activity then easing to Quite to Unsettled through day 3 (15 Jul).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	40	10	1	1
Strong	G3	No	5	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/2335	Partial Halo + Asymmetric halo shock	Filament S of AR3363	SE	870 km/s	14/1600 UTC +/-9hrs	Glancing impact. Low confidence.

Figure 2: Latest SDO/AIA 211 image showing the potential weak coronal hole feature, along with small CH23.

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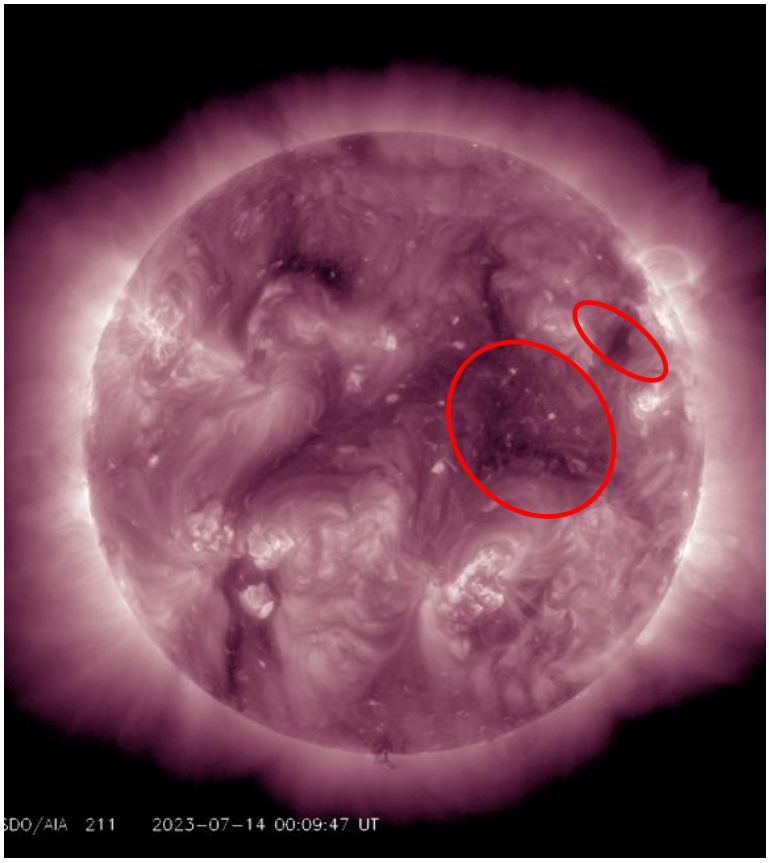
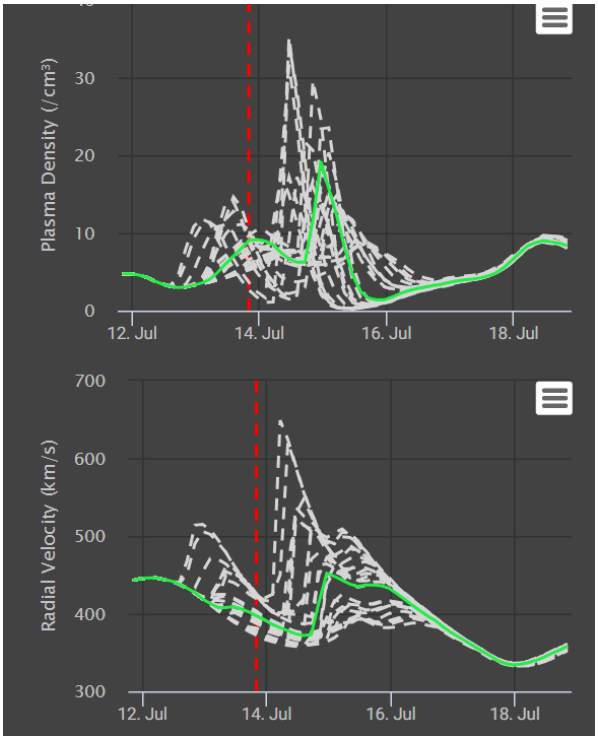


Figure 3: MOSWOC Enlil ensemble forecast.



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Radio Blackouts - X-Ray Flares:

Solar activity in the last 24 hours has been Moderate, with a M2.1 flare from AR3372 peaking at 13/1920 UTC.

There are currently seven numbered sunspot regions on the visible disc, with AR3372 still the largest and most active. This region has elongated slightly over the past 12 hours, and is now classified as a Fki/beta-gamma-delta, as there appears to be small delta spot within its complex trailer region. AR3363 is also a notable region, and is currently assessed as a Cki/beta-delta-gamma, as one or possibly two small delta spots are present. AR3367 has developed over recent hours to become another complex region, as there has been a slight increase in size with some growth of penumbra around some intermediate spots. This has lead to the development of a small delta region, and so AR3367 is now classified as Eai/beta-gamma-delta. The remaining numbered regions are smaller and simper, and either stable declining. A new region is also emerging on the east limb, and appears to be an elongated region trailing behind the east limb. Further regions are also expected to rotate onto the visible disc through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently near background and is likely to remain at this level. There is a chance of this rising towards the S1 Minor Radiation storm level, with a slight chance of exceeding, given any significant flaring from the spots on the western disc. This most likely to come from AR3363 or AR3367 which are both in the western hemisphere.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

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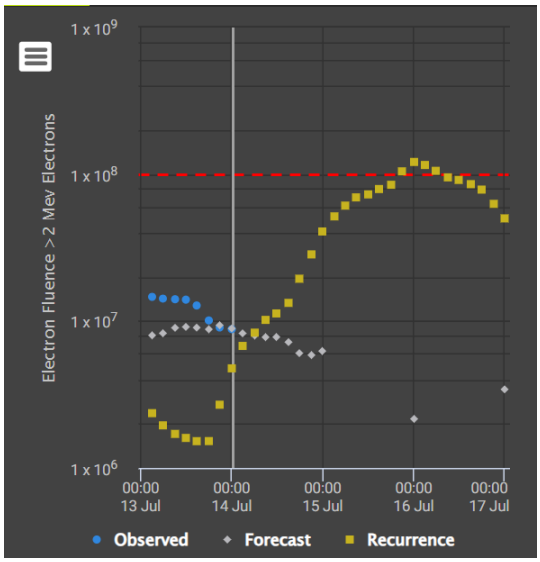
High energy electron flux (greater than 2MeV) at GEO is varying diurnally between Background and Moderate levels. The next influx of electrons into the Van Allen belt is expected to occur with the combined effect of the CME arrivals and the potential CH enhancement. Once any initial solar wind pressure eases from any of these enhancements the observed flux is expected to rise to Moderate, perhaps High levels, mainly day 3 or day 4 (16-17 Jul).
The associated 24 hour fluence is expected to remain below the Active threshold (1e8 total flux), with REFM giving a good guide in the absence of any enhancement. However, any CME or CH arrival results in REFM being unreliable later in the period. Electron fluence is expected to remain below the Active threshold (1e8 integrated pfu) but with a rising trend from day 3 (16 Jul), leading to a chance of the Active threshold being breached during day 4 (17th).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Met Office REFM model.



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